Flight Object Requirements

&

High Level Overview

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Booz Allen Hamilton

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1 INTRODUCTION

1.1 Document Purpose and Scope

This document describes the concept of Flight Object, the globally harmonized enabler for sharing consistent flight data across air transportation stakeholders. It describes the development activities associated with the Flight Object, and it introduces the data interface specification proposed for the Flight Object, called the Flight Information Exchange Model (FIXM).

1.2 Operational Need

Air transportation volume is on the rise. For example, in the United States it is expected to almost double over the next 20 years[1]. To support this growth, flight-related data must flow more easily among all concerned stakeholders. This is particularly true for international flights, where data is exchanged among systems with dissimilar capabilities. Inconsistencies in how flight data is communicated and processed by these disparate systems leads to friction at the system interfaces. This friction is a limiting factor in efficient data exchanges, and it inhibits the factors that lead to air traffic volume increase (e.g., efficient use of resources, shorter delays, and decreased workloads). In addition, the quality and availability of data must improve to support better planning and operations. Better data consistency leads to increased cost-effectiveness as well as improves safety and security in global air transportation.

1.2.1 Interoperability

Today's Air Traffic Management (ATM) systems meet their data exchange needs through mostly point-to-point interfaces. These interfaces are difficult to maintain because they do not comply (at the data level) to any particular standard. They are also less than reusable because data representation varies significantly among them. Because of the inflexible nature of these interfaces, pertinent data sometimes is not shared across domains, or the sharing requires computationally expensive and error-prone translation. When new interfaces are required, they are usually developed without the benefit of reusing the intellectual capital invested in previous interfaces.

1.2.2 Semantic Harmonization

Terminology is often inconsistent across aviation domains, and this can lead to miscommunication and lack of understanding. For example, various systems operated by the United States (U.S.) Federal Aviation Administration (FAA) may use different terms to describe something with the same meaning; Proposed-time in En Route Automation Modernization (ERAM), Proposed Gate Time of Departure (PGTD) in the Traffic Flow

[1] *FAA National Forecast 2011-2031*, February 15, 2011

Management System (TFMS), and Estimated Time of Departure (ETD) in Traffic Management Advisor (TMA) all have the same meaning. In other cases, data that has the same name in multiple systems may have a slightly different definition and usage in each of the systems.

Reducing data friction between systems is impossible without a common understanding of the definition and usage of all the data elements exchanged in the aviation domain – a semantic harmonization among the stakeholders.

1.2.3 Data Management

Currently, flight history is usually tracked using multiple legacy and advanced systems across various domains. This use of technologies of variable capabilities can lead to degradation and inconsistencies in data fidelity and storage. Post-operations analysis often relies on data gathered from multiple sources with the potential for duplicate, missing, or contradictory information. (For example, data about a sensitive flight might be published in a surface data feed but filtered from a Traffic Flow Management (TFM) data feed.) Sometimes flight data comes from verbal accounts by pilots and controllers, often well after the fact. Being able to manage the lifecycle of flight data from the planning phase through the operational phase and well into the post-operations phase would foster a safer, more rapidly-responding aviation environment.

2 PROVIDING CONSISTENT AND UP-TO-DATE FLIGHT DATA - FLIGHT OBJECT

The international aviation community is developing the Flight Object as a response to the challenges outlined in Section 1.2.

2.1 The Flight Object

The Flight Object is a complex concept that is defined by three tightly related entities, the Flight Object concept, the Flight Object system, and the Flight Object data.

1. **The Flight Object Concept**. At a conceptual level, the Flight Object is defined as the collection of processes that allow for capturing and sharing the most up-to-date information about flights throughout their lifecycles and beyond. The Flight Object makes this information available to participating Air Navigation Service Providers (ANSPs), regulatory entities, and approved airspace users. The Flight Object ensures that all aviation-related systems have a consistent and operationally-appropriate view of flight information - including aircraft type, trajectory, airframe equipment, time and location estimate data, and other information. The Flight Object achieves operational improvements through such factors as higher interoperability and coordination, better data accuracy, increased availability of up-to-date flight information, consistency of flight planning and operations among different ATM domains, and availability of operator preferences and recorded history information.

2. **The Flight Object System.** The Flight Object Operational Concept is implemented by the Flight Object System, which is a complex system of systems whose architecture has not yet been defined. This system ensures that the operational advantages postulated by the Flight Object Operational Concept are achieved in a manner that is convergent with current international modernization programs such as FAA's Next Generation Air Transportation System (NextGen) and EUROCONTROL's Single European Sky ATM Research (SESAR). The Flight Object System's main role is to maintain a complete, consistent, authoritative, and up-to-date view of flight data for past, current, and future flights. The Flight Object System may be implemented differently by the different Flight Object stakeholders, but it will still be globally interoperable. It is currently accepted that the Flight Object (in general, and the Flight Object System in particular) may support local enhancements called for by specific characteristics of regional operations.

3. **The Flight Object Data**. The Flight Object Data is the collection of all information exchanged by the Flight Object stakeholders. It is composed of individual pieces of data called Flight Data Elements (FDEs). At the data level, the Flight Object defines the meaning and format of these data elements. It also defines the way data elements are grouped, or aggregated, in clusters. Some of these clusters have particular operational meaning (e.g., the Flight Plan), while others facilitate data management [e.g., Air Traffic Control (ATC) flight handoff]. The essence of the Flight Object Data is to define and manage the sharing of the FDEs across the multitude of Flight Object stakeholders, such as aircraft operators, on-board flight management systems, military (ATC and defense units), ANSPs, TFM, airport operators, flight data processing systems, law enforcement, and security organizations. It is currently accepted that the number and types of FDEs supported by the Flight Object will evolve over time and as the Flight Object itself evolves.

It is recognized that while the Flight Object concept is maturing, the term "Flight Object" is used somewhat loosely to denote one or any combination of these entities. While this practice is often convenient, it is important to understand that the Flight Object encompasses all three aspects (harmonized operations, interoperable systems, and unambiguous data) equally. In implementation, one cannot exist without the other two.

2.2 Flight Object as a Globally Harmonized Solution

The Flight Object supports several global ATM initiatives which aim to enable advanced planning and increased efficiencies through better access to flight information. The Flight Object work is an international initiative co-developed by multiple ANSPs and regulatory bodies including the FAA, EUROCONTROL/SESAR, Japan Civil Aviation Bureau (JCAB), United Kingdom National Air Traffic Services (UK NATS), Airservices Australia, and NavCanada. When implemented, the Flight Object will allow seamless international data sharing regardless of the location, origin, or destination of a flight.

2.2.1 Next Generation Air Transportation System (NextGen)

The FAA's NextGen program is an ongoing initiative to modernize the U.S. National Airspace System (NAS). Flight Object will support the NextGen goal of "getting the right information to the right person at the right time"[2] by increasing access and decreasing the workload required to obtain flight information. The availability of harmonized information through the Flight Object supports the System Wide Information Management's (SWIM) goal of reducing point-to-point information interfaces in the NAS. NextGen is associated with numerous goals, called Operational Improvements (OIs). In particular, Operational Improvement "OI 103305: On-Demand NAS

[2] FAA, "Why NextGen Matters"

Information" relies on the Flight Object to ensure "NAS and aeronautical information is consistent across applications, and locations are available to authorized subscribers and equipped aircraft."[3] This OI will be implemented in the 2018 time frame and is a key enabler to SWIM.

2.2.2 Single European Sky ATM Research (SESAR) Master Plan

SESAR is a joint undertaking by the European Union (EU), EUROCONTROL, and industry – a development effort similar to NextGen in the U.S. – to modernize the ATM system for Europe. The SESAR Master Plan outlines the path to implement the research and development actions in SESAR. A three-step process is used to reach the goals through Time-Based Operations, Trajectory-Based Operations, and Performance-Based Operations. One of the first steps to enabling Time-Based Operations is "System Interoperability with Air/Ground Data Sharing,"[4] which is partially enabled though ground-to-ground Flight Object data exchange mechanisms and, eventually, SWIM.

2.2.3 ICAO Global ATM Concept

The International Civil Aviation Organization (ICAO) has released the *Global Air Traffic Management Operations Concept* that has the vision "To achieve an interoperable global air traffic management system, for all users during all phases of flight."[5] Global ANSP and user interoperability will be greatly advanced through use of a universal flight data exchange method and increased use of common semantics. The concept also supports the constant updating of the Flight Object to assist in flight planning, improve the effectiveness of Traffic Management Initiatives (TMIs), and increase the use of collaborative decision making (CDM).

2.2.4 Flight and Flow Information for a Collaborative Environment (FF-ICE)

The ICAO ATM Requirements and Performance Panel (ATMRPP) has developed a concept known as Flight and Flow Information for a Collaborative Environment (FF-ICE) that advances the sharing of, and mechanisms for sharing, airspace users' flight information, user preferences, search and rescue information, and access requirements.[6] FF-ICE supports the collaborative environment envisioned in ICAO's *Global Air Traffic Management Operations Concept*. The Flight Object will help meet these concept goals through increased access to existing flight information. While the FF-ICE does not mandate a specific flight object data model, it

[3] *FAA NextGen Implementation Plan*, 2012

[4] *SESAR European ATM Master Plan*, 2012

[5] *Global Air Traffic Management Operational Concept*

[6] *Manual on Flight and Flow Information for a Collaborative Environment*

does support the communication of flight and flow information among ATM stakeholders.

3 EXCHANGING FLIGHT OBJECT DATA - FIXM

The Flight Object achieves its global interoperability and harmonization goals through (among other things) a data specification called the Flight Information Exchange Model (FIXM).

3.1 FIXM

FIXM is an extensible markup language (XML) data interchange format used to communicate FDEs contained in the Flight Object[7]. It is a set of rules that define the language, format, and relationships of how flight information will be exchanged. FIXM serves as the means for airspace users and aviation-related systems to understand the meaning of the FDEs and the format in which they are expressed.

It should be noted that although the terms are sometimes used interchangeably, FIXM and the Flight Object are separate entities. FIXM is a data exchange specification (an XML schema) that facilitates the sharing of flight-related information. It is envisioned that FIXM will be used as the principal (possibly only) data interface of the Flight Object. This, however, does not preclude near- and mid-term systems from using FIXM – independently from the Flight Object – as a general-purpose, globally harmonized, modern interface that is compatible with service-oriented architectures such as FAA's SWIM.

FIXM has three major components (all of which are available at www.fixm.aero):

1. An XML schema that facilitates the building of data interfaces for exchanging a predefined set of FDEs.
2. A Unified Modeling Language (UML) data model that depicts the FDEs, their properties, and their relationships. This package includes a conceptual data model as well as a logical data model.
3. A Data Dictionary that captures the meaning and usage rules for the included FDEs. For each FDE listed in the FIXM Data Dictionary, the following information is included: definition of the FDE, alternate names that reflect various nomenclatures across systems and domains, hierarchical relationships among the existing FDEs, data types, value ranges (where applicable), business rules associated with the individual use of each FDE, additional notes regarding the FDE,

[7] While the FDE content of the Flight Object is not currently defined, there is an understanding that the FDEs most commonly used in the current exchanges among aviation systems will become – de facto – part of the Flight Object. FIXM contains a globally harmonized collection of such FDEs. More information can be found at www.fixm.aero.

and references to authoritative documents from which these FDEs are derived.

It is important to understand that the FDEs defined by the FIXM development effort (see Section 3.2) will one day be part of the flight information managed by the Flight Object. For now, the FDEs can be used (through the FIXM specification) to implement any flight information data interface, independently from the Flight Object.

FIXM is part of a family of technology-independent, harmonized, and interoperable information exchange models and XML schemas. It is designed to interoperate with the following aviation data standards:

- The Aeronautical Information Exchange Model (AIXM) enables the management and distribution of Aeronautical Information Services (AIS) data in digital format. Additional information is found at http://www.aixm.aero.
- The Weather Information Exchange Model (WXXM) enables a platform-independent, harmonized, and interoperable meteorological information exchange covering all the needs of the air transport industry. Additional information is found at http://www.wxxm.aero/.

3.2 FIXM Development

FIXM is currently being developed collaboratively by a multinational, interdisciplinary team. Based on the experience of legacy interfaces, new concepts such as Flight Object Interoperability Specification (ED-133) and FF-ICE, and existing standards such as Procedures for Air Navigation Services and Air Traffic Management (ICAO 4444), the FIXM team is systematically developing the definitions and modular representations of the FDEs that will become part of the Flight Object.

3.2.1 FIXM Technical Review Board

A FIXM Technical Review Board has been established to identify candidate FDEs for the Flight Object, develop a Data Dictionary to describe the FDEs, develop a FIXM XML schema, solidify the operational concept for Flight Object, identify issues related to the use of FIXM, and suggest resolutions. The FIXM Technical Review Board is comprised of members of the FAA, several other ANSPs (EUROCONTROL, Airservices Australia, NATS UK, JCAB), and industry.

3.2.2 FIXM Releases

FIXM version 1.0 was released in August 2012. This release is associated with the exchange of data in the ICAO 2012 Flight Plan and the Globally Unique Flight Identifier (GUFI). In December 2012, FIXM version 1.1 was

released; it added the exchange of information associated with transporting hazardous air cargo. FIXM version 2.0 is scheduled for release in 2013. It will include all of FIXM 1.1 with the additional FDEs that appear in Air Traffic Services (ATS) messages, ATS Interfacility Data Communications (AIDC) messages, Traffic Flow Management Data Exchange (TFMDE), FAA/Airservices Australia CDM, Fleet Prioritization, Flight Data Processing System (FDPS), ANSP-ANSP boundary crossings, Airport Surface Detection Equipment - Model X (ASDE-X), Aircraft Situational Display to Industry (ASDI)/Flight Training Manual (FTM) connect, Add Code Share, and Airport CDM. Each FIXM release includes a logical data model, an XML schema, and a Data Dictionary.

3.2.3 Demonstrations

A series of demonstrations is being planned by the FAA, EUROCONTROL, and Airservices Australia to test various aspects of the FIXM concept, illustrate potential benefits of FIXM, and identify challenges and issues in implementing FIXM. Three FIXM demonstrations have been conducted thus far and have successfully shown the following:

- Flight Object exchange between oceanic ATC systems (U.S. and Portugal) across the Atlantic Ocean
- Potential benefits by enabling Flight Object exchange among Atlantic-based airport surface stakeholders, ANSP entities, and flight operators
- Gate-to-gate scenarios involving Pacific-based surface, en route, and oceanic systems, as well as some simulated future Flight Object-enabled systems. The scenarios illustrated the following concepts:
    - Real-time exchange of hazardous cargo information between airlines and airports
    - Ability for airlines to view in real-time their flight sequences with assigned priorities
    - More efficient coordination in an oceanic conflict situation

FIXM demonstrations are being conducted on the NextGen Test Bed in Daytona, Florida. The demonstrations also illustrate the use of SWIM core services in the exchange of flight data. The next scheduled FIXM demonstration will emphasize a “mini-global” environment that will build on the previous Atlantic and Pacific demonstrations. Additional information about the FIXM demonstrations can be found at http://www.fixm.aero.

4 FLIGHT OBJECT OVERVIEW

4.1 Operational Concept Overview

This section provides an overview of the operational concept of the Flight Object.

4.1.1 High Level Architecture

Today, when aviation automation systems (such as the ATC systems of two ANSPs) require an exchange of flight data, system owners agree on the method of transmission, data formats, frequency of transmission, and other details which are then specified in Interface Requirements Documents (IRDs) and Interface Control Documents (ICDs) for the two systems. Adding a new interface – or modifying existing ones – is costly and complex. In many cases, systems maintain different data sets of semantically equivalent information about the same flight, resulting in information segmentation. Furthermore, because these systems often name the same data elements differently and represent them differently, a translation layer is required for these systems to communicate. Figure 3-1 illustrates the flight data communication situation today.

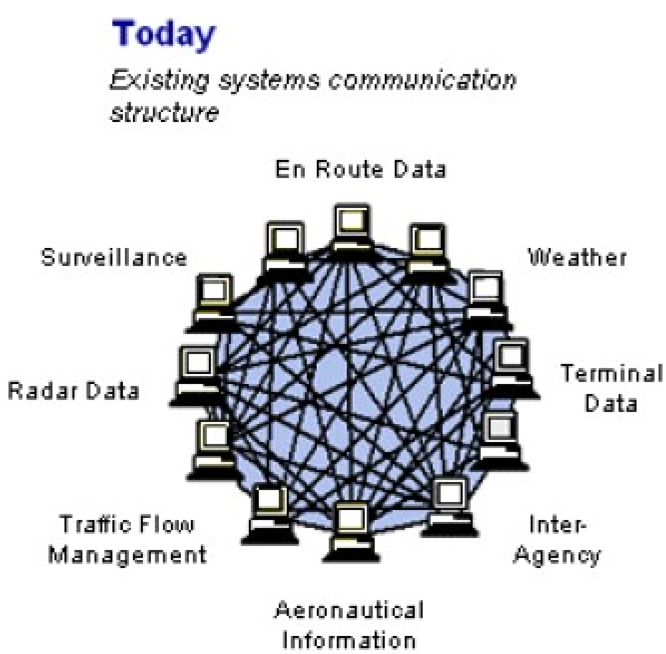

Figure 4-1: Point-to-Point Exchange of Flight Data among Current Air Traffic Systems[8]

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[8] Picture is courtesy of the John A. Volpe National Transportation Systems Center.

In the Flight Object concept, such flight data no longer need to be sent system to system according to the protocol specified in their ICDs. Instead, flight data are available from a single resource. There is no need to arbitrate among different sources of the data – the Flight Object contains the authoritative value for each exchanged FDE. The Flight Object is updated in real-time by data derived from any number of systems – including ATC systems, airspace user fight planning systems, on-board avionics, and airport automation systems – and according to established rules followed by all data providers. The data in the Flight Object are also time-stamped so that the user of the data can ascertain when the most recent update to the data occurred. Figure 2-2 illustrates the flight data exchange among flight data users and providers in the Flight Object concept.

Figure 4-2: Flight Data Exchange in the Flight Object Concept[9]

There are several kinds of data associated with a flight, some of which remain internal to the system or organization that produces the data. Currently, it is envisioned that only the flight data that are exchanged with other systems are placed in a Flight Object. For example, data in which only the air carrier has an interest, such as proprietary data, need not be managed by the Flight Object.

While the implementation details of the Flight Object are not yet defined, the following notional example may be useful to illustrate how the Flight

[9] Picture is courtesy of the John A. Volpe National Transportation Systems Center.

Object could exchange data. Accessing the data in the Flight Object is coordinated through a subscription service - that is, if an automation system has need of specific data about the flight, it subscribes to the Flight Object for that flight. This entitles that system to retrieve or update FDE values from the Flight Object at any time during (and after) the flight's duration. Rules to enable or disable a system to update an FDE are determined when the Flight Object is created.

4.1.2 Users of the Flight Object

There are many potential users and uses of the data in a Flight Object. Typical users of Flight Object data (and their areas of interest) include the following:

- Airspace users
    - Flight planning
    - Flight following
    - Air carrier network planners
    - Aircraft maintenance
- ANSPs
    - ATC
        - Aircraft separation
        - Flight plan processing
        - Flight following
    - TFM
        - Understanding demand over time of NAS resources
        - Understanding capacity over time of NAS resources
        - Developing effective TMIs
        - "What-if" analyses
        - Notification of airspace and airport constraints
        - Notification of planned or active TMIs
- Airports
    - Ground services (e.g., airplane turnaround activities, catering, baggage handling)
    - Gate management
    - Ramp control
    - De-icing services
- Airspace security
    - Identification of flights carrying hazardous cargo
    - Rapid coordination in event of security situation
- Airspace Analysts
    - Post-operations analysis

- Improvement of development and execution of TMIs

4.1.3 Notional Example: Overview of the Flight Object for a Nominal Flight

This section illustrates possible activities and their associated flight data that are exchanged with the Flight Object for a nominal flight. This example is notional, because specific details on roles and responsibilities, rules, implementation of the Flight Object, and so forth are dependent on system architecture and have not been finalized.

The Flight Object defines a flight as an aircraft trip taking off at a departure aerodrome and landing at the arrival aerodrome[10]. (In other contexts, this might be considered a "flight leg.") Thus, a single airframe may experience multiple flights on any given day, and a passenger who boards that aircraft may travel on multiple flights before arriving at the passenger's final destination.

4.1.3.1 Pre-Departure

As soon as an airspace user chooses to publish data about its schedule or make details about a flight known to others, a unique identifier for the flight, called a Globally Unique Flight Identifier (GUFI), is assigned. The GUFI permanently associates a flight with all of its corresponding FDEs.

Airspace users gather information about conditions of the NAS and other Flight Information Regions (FIRs) to plan their flights. Users factor in their crew and airframe availability, weather predictions, and their network operation objectives for the day. At this point, they develop early intent flight plans whose information is communicated to the Flight Object.

Such data as the following may be entered initially by the airspace user into the Flight Object and may be updated several times by the airspace user or other systems before the flight's departure:

- Aircraft identification
- Departure time estimate
- Arrival time estimate
- Route
- Aircraft capabilities (e.g., navigation, communication, equipage to fly over water, self-separation)

[10] This is a simplified definition for the purposes of illustration. The Flight Object notion of flight contains information from gate to gate. (It includes pre-takeoff and post-landing surface movement, for example.)

- Departure prioritization of an airline’s flights from a given airport

4.1.3.2 Departure

As the aircraft nears departure time, details about the departure become more clear. Airspace users continuously monitor their network of operations, noting delays, as well as crew and aircraft availability, and update the Flight Objects as necessary. Ground services and other airport crew plan their resources around departure and gate information available in the Flight Object. Tower and terminal systems monitor their demand estimates with Flight Object data.

The airspace user, tower automation, or other ATC automation may enter, update, or use these typical flight data in the Flight Object:

- Departure time
- Arrival time estimate
- Route
- Departure gate
- Fuel on board
- Aircraft weight
- Minimum Equipment List (MEL)
- Passenger information (e.g., count)
- Cargo information (e.g., contents of hazardous cargo)
- Controlled time of departure, in the case of airport ground delays
- Runway and taxiway preferences
- Departure prioritization of an airline’s fleet from a given airport

4.1.3.3 En Route

In the en route phase of flight, the data in the Flight Object are updated frequently by ATC automation and on-board avionics. The airspace user can monitor flight progress and performance using data contained in the Flight Object. Downstream automation systems (e.g., en route or arrival) monitor demand for their resources using data from the Flight Object. When controlled times are required to manage airspace or airport constraints, coordination of airspace user preferences can be facilitated via the Flight Object. Additionally, if a security event were to arise, authorities could access the information about the flights of interest – through the Flight Object – to assess the situation and plan appropriate courses of action.

Typical Flight Object data that may be updated or used while the aircraft is en route include the following:

- Arrival time estimate
- Route
- Fuel on board
- Fix arrival times
- Airspace user preferences for fleet prioritization for en route resources
- Other airspace user preferences (e.g., cruise level, reroute preferences)
- Controlled time of arrival (CTA) to an airspace experiencing a capacity constraint
- Information about critical situations that have developed on board (e.g., passenger requiring medical services, security situation, maintenance issues)

4.1.3.4 Arrival

As the aircraft nears the arrival airport, information in the Flight Object is used to plan ground services and resources at the airport arrival gate. If an airline finds that an airframe unexpectedly becomes unavailable for service, it must adjust its network objectives for the day, amend its schedule, and re-plan its resources accordingly. These changes can be communicated to others via the Flight Object.

Typical flight data updated or used in the Flight Object during the arrival phase of flight include the following:

- Arrival time
- Fuel on board
- Route
- Arrival gate
- Airspace user preferences about fleet prioritization for arrival fixes or aerodrome resources
- Other airspace user preferences (e.g., runways, taxiways, gates)

4.2 Key Concepts

While aviation has never been safer, it is recognized that improvements in storing, accessing, and communicating information about a flight are needed. The concept of a Flight Object has been recognized for many years, not just by the U.S. NAS but by other FIRs as well. While research and engineering continue to better define the Flight Object, rules of use, roles and responsibilities, and architecture considerations, and important ideas have been guiding research efforts about the Flight Object. This

section discusses those key ideas. Information about engineering analyses for these Flight Object concepts can be found at http://www.fixm.aero.

4.2.1 Single Resource for Exchanged Flight Data

When the Flight Object is implemented, the exchange of flight data will be more easily facilitated because there will be a single authoritative source for all of the data pertaining to a single flight. Having flight data accessible from a single source and through a common infrastructure will do the following:

- Make it easier to access flight data
- Control access
- Ensure a consistent format of the data and consistent meaning; remove ambiguity
- Provide a single picture of flight intent and activity
- Standardize rules for data access
- Remove redundancy of data
- Simplify data processing
- Facilitate post-operations analysis

4.2.2 Globally Unique Flight Identifier (GUFI)

The GUFI is assigned as soon as exchange of a flight's data with other systems is needed - for example, at flight plan filing - and remains the unique identifier for that flight. Whenever subsequent transactions for the flight are made, the GUFI is included in the transaction. The GUFI is associated with the flight forever and, once assigned, is never reused. The GUFI is recognized as the unique identifier across all FIRs and by all ANSPs. The GUFI concept is important because it addresses the current issue of correlating data from different sources, such as the Official Airline Guide (OAG), airspace user flight plans, and flight plans from other ANSPs. More information about the GUFI proposed to be used by the Flight Object can be found at http://www.fixm.aero.

4.2.3 FIXM Core vs. Extension

All ANSPs have the need to update a common set of data about each flight. Because ANSPs have unique challenges and issues in their airspace, there may be additional flight data that are of interest to some ANSPs but not to others. In FIXM, the concept of Core and Extension has been introduced. The FIXM Core contains the flight data that all participating ANSPs are required to send and receive. In addition, ANSPs may establish FIXM

extensions for data unique to their operation. FIXM will be designed so that a system can retrieve data seamlessly from either FIXM Core or Extensions.

An open-source process will be established to register, test, and evaluate FIXM extensions.

4.2.5 Transition to Flight Object

Not all users of flight data will be able to immediately transition their automation systems and processes to be Flight Object-compliant. ANSP automation will accommodate both Flight Object users and non-Flight Object users. Each aviation system would most likely continue to maintain a legacy method and a Flight Object method for exchanging flight information for an indefinite time.

5 BENEFITS OF FLIGHT OBJECT

To be successful, the Flight Object must provide real benefits in the planning, operational, and post-operational phases of the flight. The benefits are closely correlated with the operational needs outlined in Section 1. While some of the operational needs could be addressed through other means, it is widely recognized that the Flight Object provides a flexible solution that is aligned with the long-term growth, safety, and efficiency goals of ANSPs. The Flight Object is technically compatible with the architectures proposed by SESAR and NextGen, and with the principles of modern high-availability data exchange architectures.

5.1 Interoperability

The Flight Object ensures interoperability on multiple levels.

1. **Data Discovery**. The Flight Object allows systems to discover flight-related data and subscribe to it. This means that once an interface to the Flight Object is established, the types of data consumed through that interface can be augmented with relative ease.
2. **Standardized Interfaces**. The interfaces to the Flight Object are standardized both at the data definition level (the FIXM level) and at the physical interface level (currently thought to be a SWIM-compliant interface). This standardization allows stakeholders to deploy new systems faster and less expensively.
3. **Higher Throughput**. The Flight Object interfaces will support scalable throughput and will have quality of service controls. They will rely on a separately developed infrastructure (SWIM) for data exchange services – this means that systems will be able to reuse interface strategies and services.
4. **Unambiguous Data**. A single globally unique identifier for each flight used by all aviation systems ensures consistency of flight information and reduces ambiguity. The need for human intervention decreases, thus saving operational cost and time. The GUFI simplifies the data archiving process and allows for the recovery of data that may have been lost due to a variety of reasons.
5. **Flexibility of the Exchange Model and Schema**. A modular construct allows for the expansion of FDEs. FIXM provides for growth and flexibility that are required to support evolving NextGen programs and automation systems, as well as data exchanges with

international stakeholders. FIXM removes the need to develop additional IRDs and ICDs for each new aviation system, thus saving development cost. (For example, the entire set of FDEs associated with Hazardous Cargo was added to FIXM without the need to amend other unrelated FDEs.)

5.2 Harmonization

The Flight Object combines the institutional knowledge of aviation stakeholders around the world to standardize the meaning of flight data and how this data is used across systems, agencies, and various countries. This is a huge benefit to the aviation community, because it provides stakeholders with common naming, meaning, and data representations for flight data. This eliminates the misinterpretation of information that can lead to performance degradation (e.g., due to incorrect demand/capacity predictions) and potential safety impacts. As a result, operational efficiency is improved.

The harmonized vocabulary provided by the Flight Object attempts to eliminate the need for data translation, which is both slow and error-prone. It also reduces data duplication by ensuring that synonyms are eliminated – that is, systems will not exchange the same data under multiple names. This consolidation has significant performance implications through data volume reduction.

5.3 Data Management

The Flight Object allows stakeholders to have a holistic view of the flight's lifecycle. The GUFI enables more precise post-operations analysis than previously possible. Airspace users can better communicate with ANSPs their long-term flight intent, and they can more precisely account for flights that are cancelled or whose schedule is changed significantly.

The Flight Object allows aggregation of data that has previously been very difficult – sometimes impossible – to achieve. Through data mining, all stakeholders will be able to gain deeper insight into how the airspace is used, identify systemic inefficiencies that are not currently apparent, and develop better ways of optimizing airspace for the air traffic of the future.

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APPENDIX A: LIST OF ACRONYMS AND ABBREVIATIONS

Acronym or Abbreviation	Definition
AIDC	ATS Interfacility Data Communications
AIS	Aeronautical Information Services
AIXM	Aeronautical Information Exchange Model
ANSP	Air Navigation Service Provider
ASDE-X	Airport Surface Detection Equipment - Model X
ASDI	Aircraft Situational Display to Industry
ATC	Air Traffic Control
ATM	Air Traffic Management
ATMRPP	ATM Requirements and Performance Panel
ATS	Air Traffic Services
CDM	Collaborative Decision Making
CTA	Controlled Time of Arrival
DAL	Delta Air Lines
ERAM	En Route Automation Modernization
ETD	Estimated Time of Departure
EU	European Union
EUROCONTROL	European Organisation for the Safety of Air Navigation
FAA	Federal Aviation Administration
FDE	Flight Data Element
FDPS	Flight Data Processing System
FF-ICE	Flight and Flow Information for a Collaborative Environment
FIR	Flight Information Region
FIXM	Flight Information Exchange Model
FMS	Flight Management System
FOC	Flight Operations Center
FTM	Flight Training Manual
GUFI	Globally Unique Flight Identifier

ICAO	International Civil Aviation Organization
ICD	Interface Control Document
IRD	Interface Requirements Document
JCAB	Japan Civil Aviation Bureau
JFK	John F. Kennedy International Airport
LAX	Los Angeles International Airport
MAD	Madrid Barajas Airport
MEL	Minimum Equipment List
N90	New York TRACON
NAS	National Airspace System
NATS	National Air Traffic Services
NextGen	Next Generation Air Transportation System
OAG	Official Airline Guide
OI	Operational Improvement
ORD	Chicago O’Hare International Airport
PGTD	Proposed Gate Time of Departure
SESAR	Single European Sky Air Traffic Management Research
STAR	Standard Terminal Arrival Route
SWIM	System Wide Information Management System
TFM	Traffic Flow Management
TFMDE	Traffic Flow Management Data Exchange
TFMS	Traffic Flow Management System
TMA	Traffic Management Advisor
TMI	Traffic Management Initiative
TRACON	Terminal Radar Approach Control
UK	United Kingdom
UML	Unified Modeling Language
U.S.	United States
UTC	Coordinated Universal Time

WXXM	Weather Information Exchange Model
XML	Extensible Markup Language

APPENDIX B: OPERATIONAL SCENARIO

B.1 Scenario: Nominal International Flight Using Flight Object

This section illustrates how a Flight Object is initiated and updated as an aircraft follows its path to its destination. In this scenario, the aircraft begins its journey at Chicago O'Hare International Airport (ORD), lands at John F. Kennedy International Airport (JFK) in New York City to accept additional passengers, then continues to its final destination, Madrid Barajas Airport (MAD) in Spain – a total of two flights (from the Flight Object concept's point of view). Along the way, the aircraft traverses several facilities within the NAS and several FIRs, each updating the respective Flight Object for the two flights. Times in this scenario are indicated for illustrative purposes only, and are expressed in Coordinated Universal Time (UTC). Additionally, although the roles and responsibilities, and rules for updating the Flight Object are not known at this time, they are postulated in this scenario to illustrate key aspects of the Flight Object.

Scenario:

May 1	Delta Air Lines (DAL) files a flight plan for its aircraft, whose tail number is N1234, with the following itinerary: • The aircraft begins as flight DAL3288 departing ORD at 20:45 Saturday, May 4, and arriving at JFK at 22:58 • The aircraft departs JFK with a different flight number, DAL0003, at 00:15 Sunday, May 5, and is scheduled to arrive at MAD at 06:35 on May 5
May 1	A GUFI is assigned to each of DAL 3288 and DAL0003 for their departures on May 4 and 5, respectively.
May 4, 00:00	Delta's system populates the Flight Object of each of the flights with their flight data, including the assigned GUFIs.
May 4, 20:45	DAL3288 departs ORD as scheduled.

May 4, 21:30	A thunderstorm develops in en route airspace; DAL3288 is given a reroute by TFM. The rerouting causes the flight to be behind its schedule by 10 minutes. The enroute center automation updates the Flight Object with the route information and revised times for fix crossing, runway, and gate arrival. Delta Air Lines has been monitoring the situation and continually adjusts its fleet prioritization at key resources in the NAS, entering fleet prioritization information into the Flight Object of its affected flights. In particular, DAL 3288 is given higher priority over other flights in its fleet that are arriving at JFK within 15 minutes of DAL 3288. Traffic Flow Managers consult Delta's fleet prioritization specification as flights approach constrained fixes, and, whenever possible, attempt to satisfy the prioritizations indicated.
May 4, 22:40	After DAL 3288 enters New York Terminal Radar Approach Control (TRACON) (N90) airspace, the wind direction at the airport shifts from north to south. All arrivals to JFK are rerouted to the northern approach fix, resulting in an additional 15-minute delay for DAL 3288.
May 4, 22:50	The Flight Object FDE, Arrival Time-Actual, is updated to 23:32. The pilot inputs the Standard Terminal Arrival Route (STAR) approach into the Flight Management System (FMS), including assigned runway 13R. The Flight Object FDE, Arrival Runway, is updated.
May 4, 23:32	DAL 3288 arrives at JFK
May 4, 23:47	DAL0003's departure time is delayed by10 minutes. Its Flight Object FDE, Departure Time-Estimated, is updated to 00:25. Automation systems monitoring the NAS have immediate access to the updated arrival and departure information.
May 4, 23:55	Another aircraft in the Delta fleet, DAL0087, is scheduled to depart JFK at 00:25 on May 5, arriving at

Los Angeles International Airport (LAX) at 06:50. DAL 0087 is already positioned at JFK.

Following the Delta fleet prioritization, DAL0087 incurs a departure delay to allow DAL0003 to depart at its revised departure time of 00:25. The following FDEs are updated in the respective Flight Objects:

DAL0003: Departure Time-Actual to 00:25
DAL0087: Departure Time-Actual to 00:33

May 5, 00:25	DAL0003 departs JFK. The Flight Object is updated with the actual time of departure. Wind conditions are such that DAL0003 flies a southern route in the North Atlantic Tracks from JFK to MAD. The pilot inputs the assigned track into the FMS. The Flight Object FDE, Route, is updated.
May 5, 00:25-06:35	DAL003 flies its planned route through New York Center airspace, Santa Maria Oceanic FIR (controlled by Portugal), and finally to Madrid's terminal approach control airspace. The Flight Object is updated throughout its flight.
May 5, 06:35	DAL003 arrives at MAD. The Flight Object is updated with actual arrival runway, actual runway arrival time, and actual gate arrival time.

Figure B-1 illustrates DAL 3288's and DAL003's flight paths in the NAS and across the Atlantic Ocean.

*image not to scale

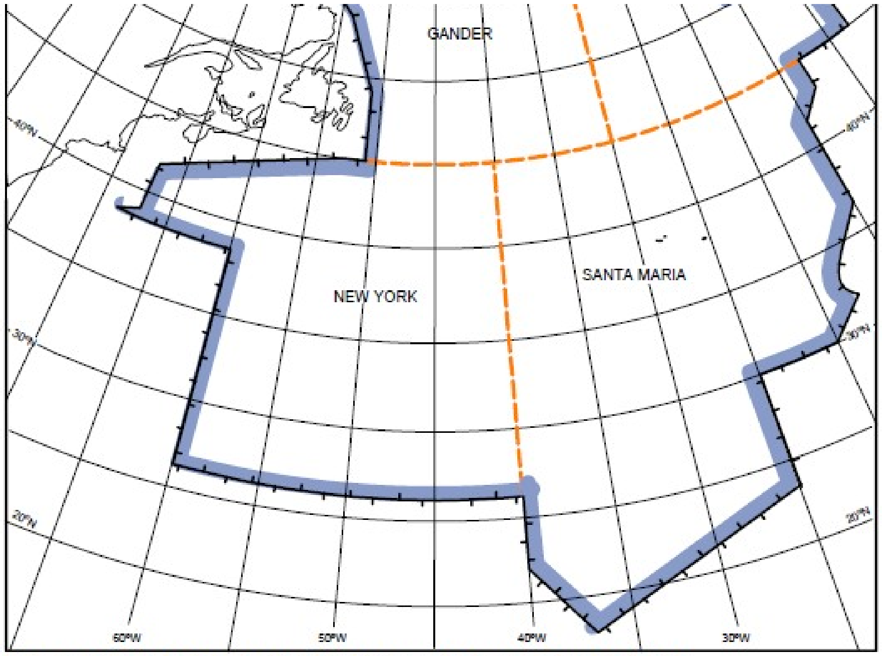

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Figure B-1: Ground Track for DAL0003[11]

B.2 The Flight Object in a Flight's Life Cycle

This operational scenario illustrates the ease of access to and exchange of information that will be available through the Flight Object. This scenario was developed under the following assumptions: data communication is available and widely used by aircraft; decision support and collaboration tools provide common situational awareness among ANSP, airspace users, and operators; arrival, departure and surface management tools are available and fielded; and policies are in place for secure information data sharing access and exchange between net-centric environments.

In today's air traffic environment, controllers and ATC systems manage and interact with a flight throughout its duration, from pre-flight checks to arrival at the gate. Depending on the aircraft's on-board technology, flight information needed by ATC to manage the aircraft must be obtained via voice communications with the pilot. Such verbal communication is a possible source of error and also contributes to radio frequency congestion. For example, if a pilot requests a diversion to a new destination due to mechanical error or a system constraint, the request is conducted via voice communication, and this information is then relayed verbally to all other ATCs that will manage the flight. Additionally, flight information such as assigned speed or heading must be coordinated verbally among ATC sectors and facilities.

[11] Picture is courtesy of *North Atlantic MNPS Airspace Operations Manual*, 2008.

Through the Flight Object, a wealth of information can be exchanged among ANSPs, the aircraft, the Flight Operations Center (FOC) and other applicable parties. Information - such as assigned airspeed, climb/descent rate and heading; aircraft and pilot capabilities; fleet prioritization and user preferences; arrival and departure runway, terminal and gate assignment, as well as the scheduled, actual, and estimated times at those points - is exchanged and updated via the Flight Object.

Prior to departure, aircraft operators file a flight plan which is assessed against existing, planned, and forecast constraints. Flight plan revisions can be negotiated and revised pre- and post-departure to mitigate those constraints. This information will be updated in the Flight Object immediately and provided to air traffic controllers who will manage the aircraft later in its flight. Any change to flight data that occurs before and during a flight is captured and updated through the Flight Object. Departure and enroute information, flight intent and user preferences, aircraft performance and wake turbulence data, aircraft and pilot capabilities, and traffic management constraints and initiatives are kept up-to-date in the Flight Object. Sharing flight information contained within the Flight Object in an agreed terminology and format, will improve the accuracy of information updates, trajectory modeling and decision making, consistency of flight information, and transition of flights between different domains.